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**Taguchi**

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(54) **INSPECTION APPARATUS, PTP PACKAGING MACHINE, AND METHOD FOR MANUFACTURING PTP SHEET**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0206914 A1\* 10/2004 Schomacker ..... G01N 21/31 250/458.1  
2004/0208385 A1\* 10/2004 Jiang ..... A61B 5/7264 382/254

FOREIGN PATENT DOCUMENTS

JP 2014-215177 A 11/2014  
JP 2015-77113 A 4/2015

(Continued)

OTHER PUBLICATIONS

International Preliminary Report on Patentability issued for PCT/JP2019/028999, dated Mar. 23, 2021 (23 pages).

(Continued)

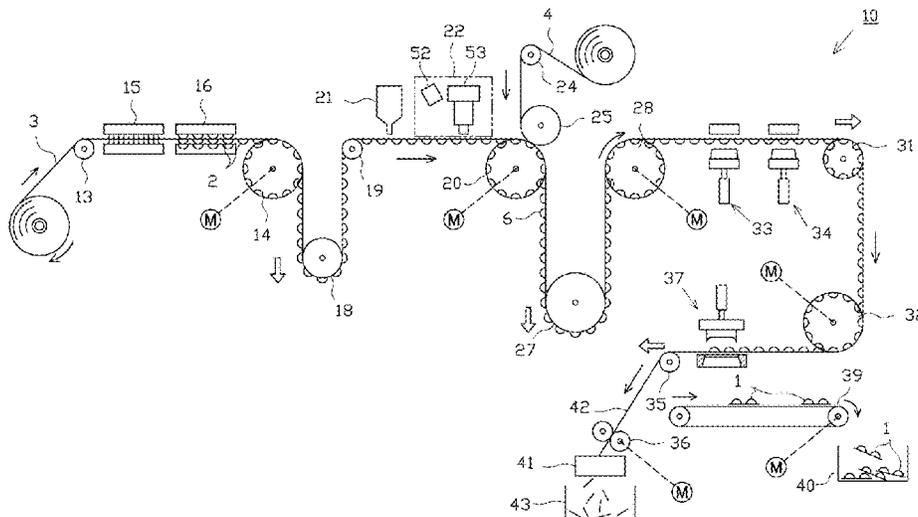
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(57) **ABSTRACT**

An inspection device includes: an illumination device that irradiates an object with near infrared light; a spectroscope that disperses reflected light from the object irradiated with the near infrared light; an imaging device that takes a spectroscopic image of the reflected light dispersed by the spectroscope; and a processor. The processor: obtains spectral data at a plurality of points on the object based on the spectroscopic image obtained by the imaging device; selects, as typical spectral data representing the object from among the spectral data at the plurality of points, one of: spectral data in which a luminance value in a predetermined wavelength is a median value; and spectral data in which a summation of luminance values in a predetermined wavelength range is a median value; and performs a predetermined analysis for the object based on the typical spectral data and detects a different type of object.

**3 Claims, 11 Drawing Sheets**



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*G01N 21/88* (2006.01)  
*G01N 21/17* (2006.01)
- (52) **U.S. Cl.**  
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(2013.01); *G01N 2021/8887* (2013.01); *G01N*  
*2201/04* (2013.01)
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(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	2017-32371 A	2/2017
JP	6329668 B1	5/2018
JP	2018-136189 A	8/2018
WO	2005/038443 A1	4/2005
WO	2013/002291 A1	1/2013

OTHER PUBLICATIONS

Notice of Reasons for Refusal issued in corresponding Japanese Patent Application No. 2018-185204 dated Jan. 14, 2020 (15 pages).  
International Search Report issued in corresponding International Application No. PCT/JP2019/028999 dated Oct. 8, 2019 (5 pages).

\* cited by examiner

FIG. 1A

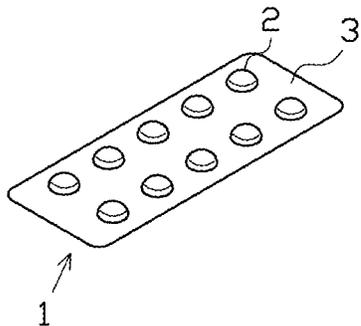


FIG. 1B

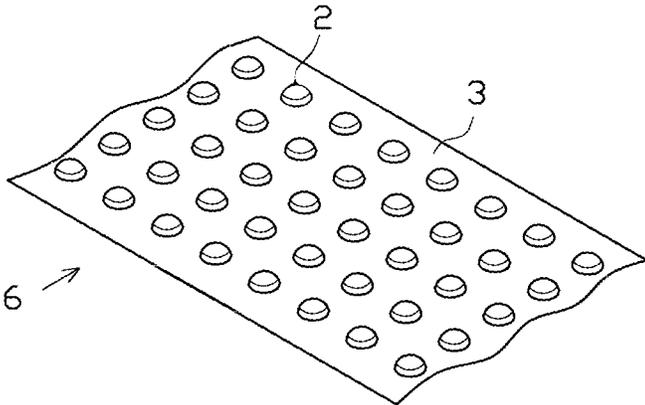


FIG. 2

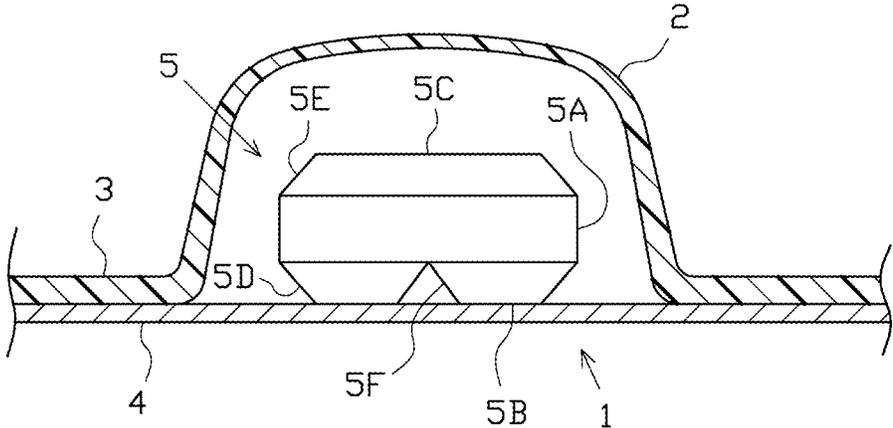


FIG. 3

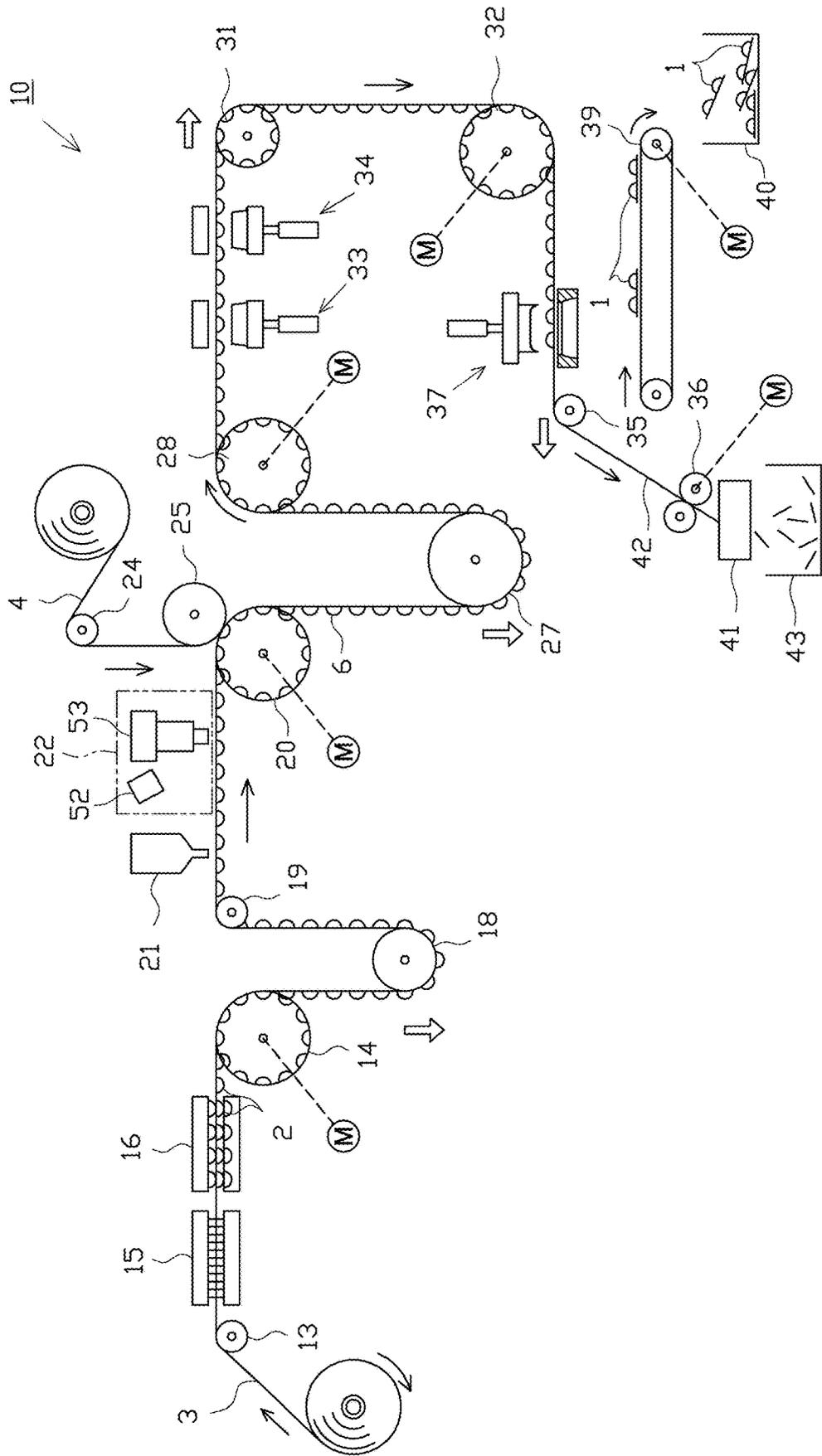


FIG. 4

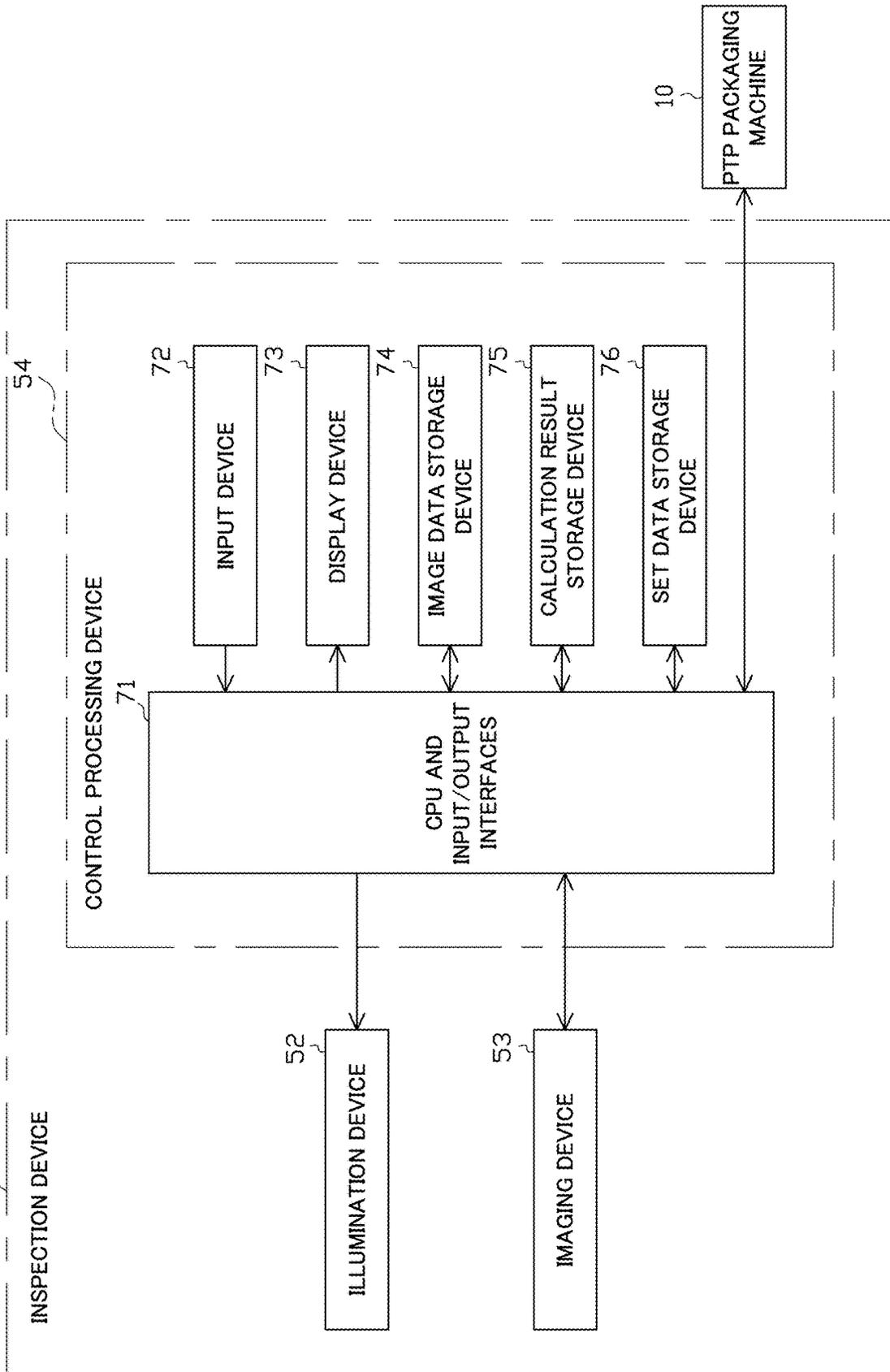


FIG. 5

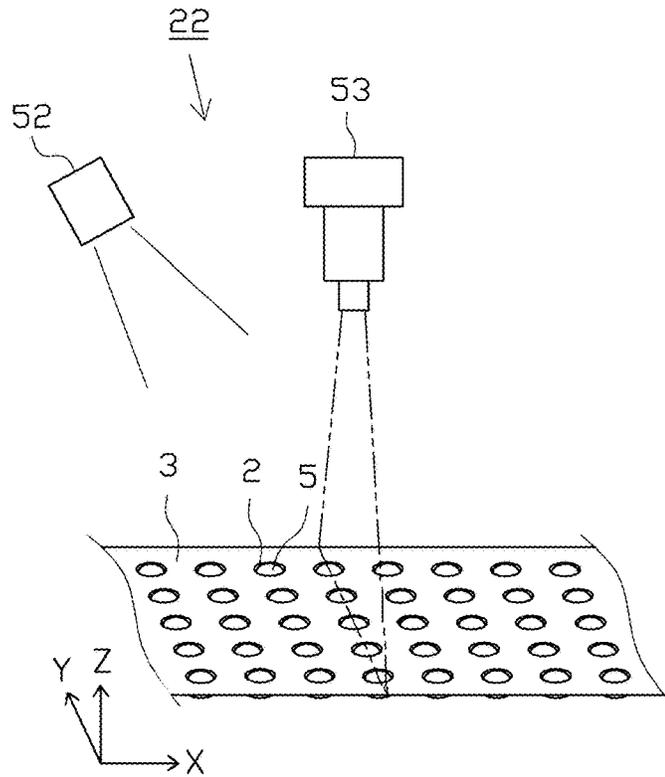


FIG. 6

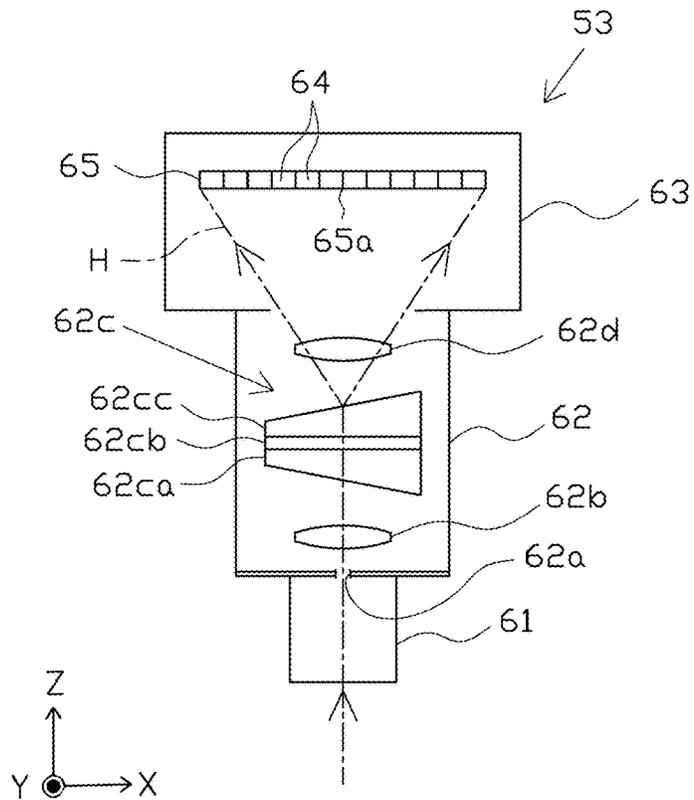


FIG. 7

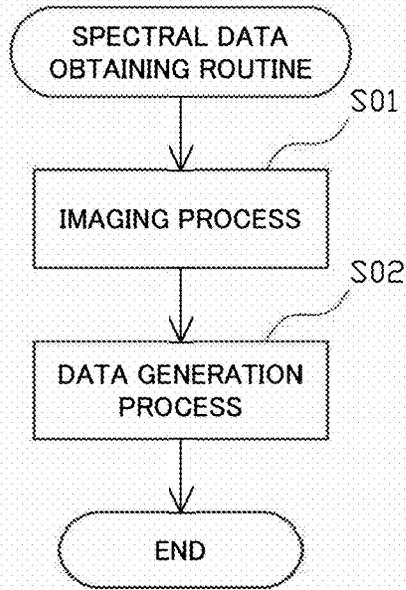


FIG. 8

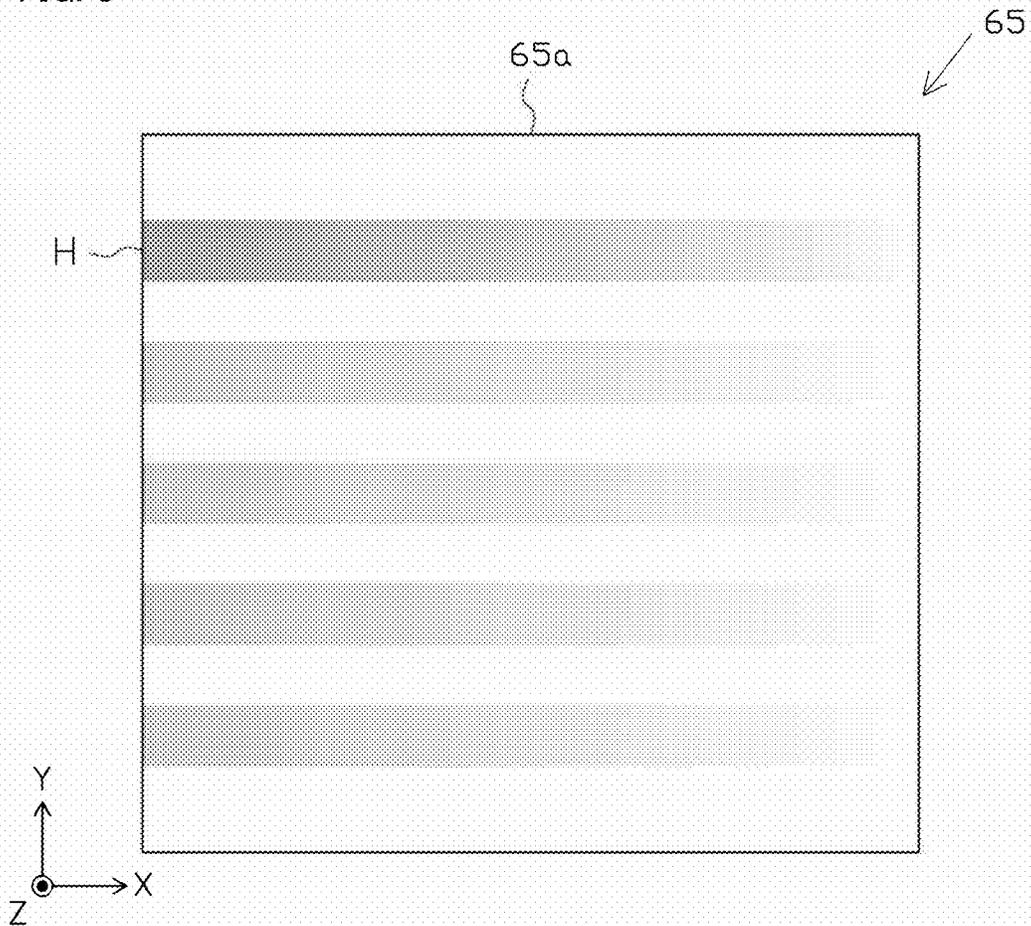


FIG. 9

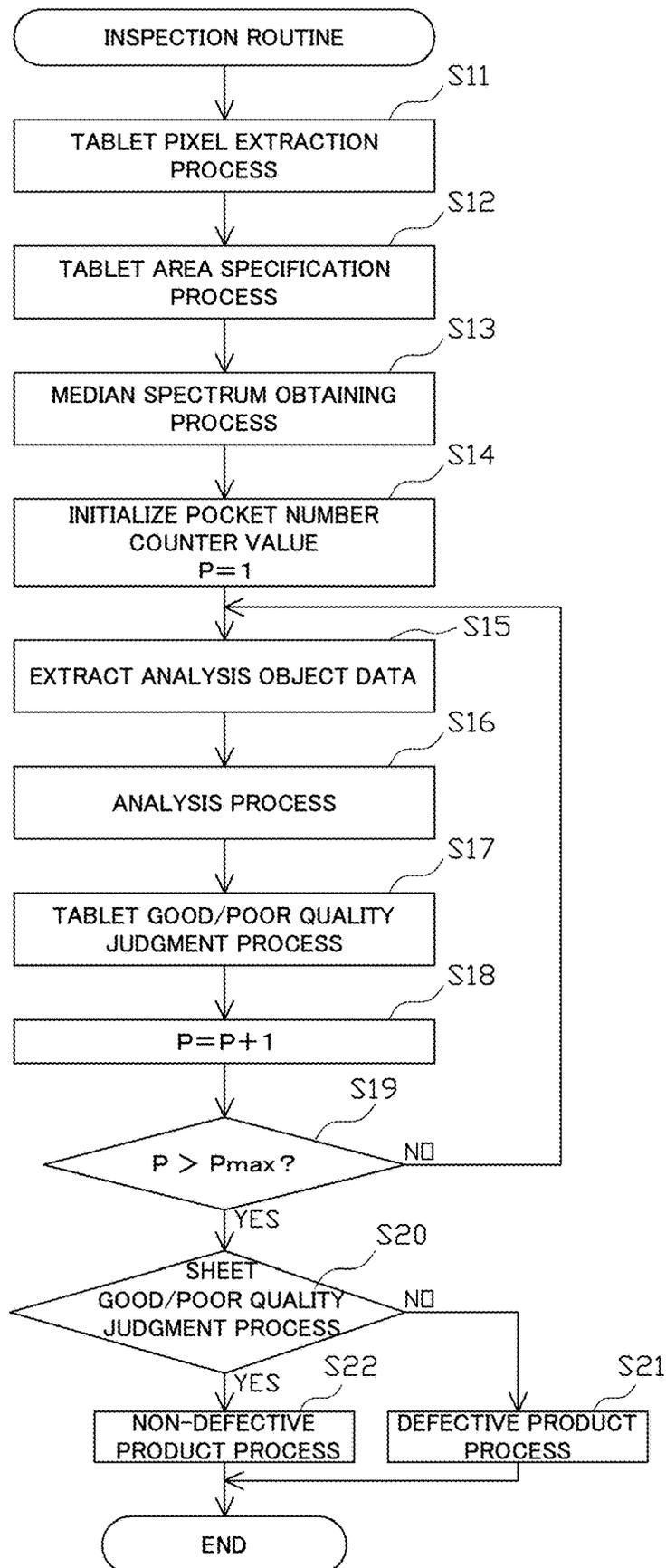
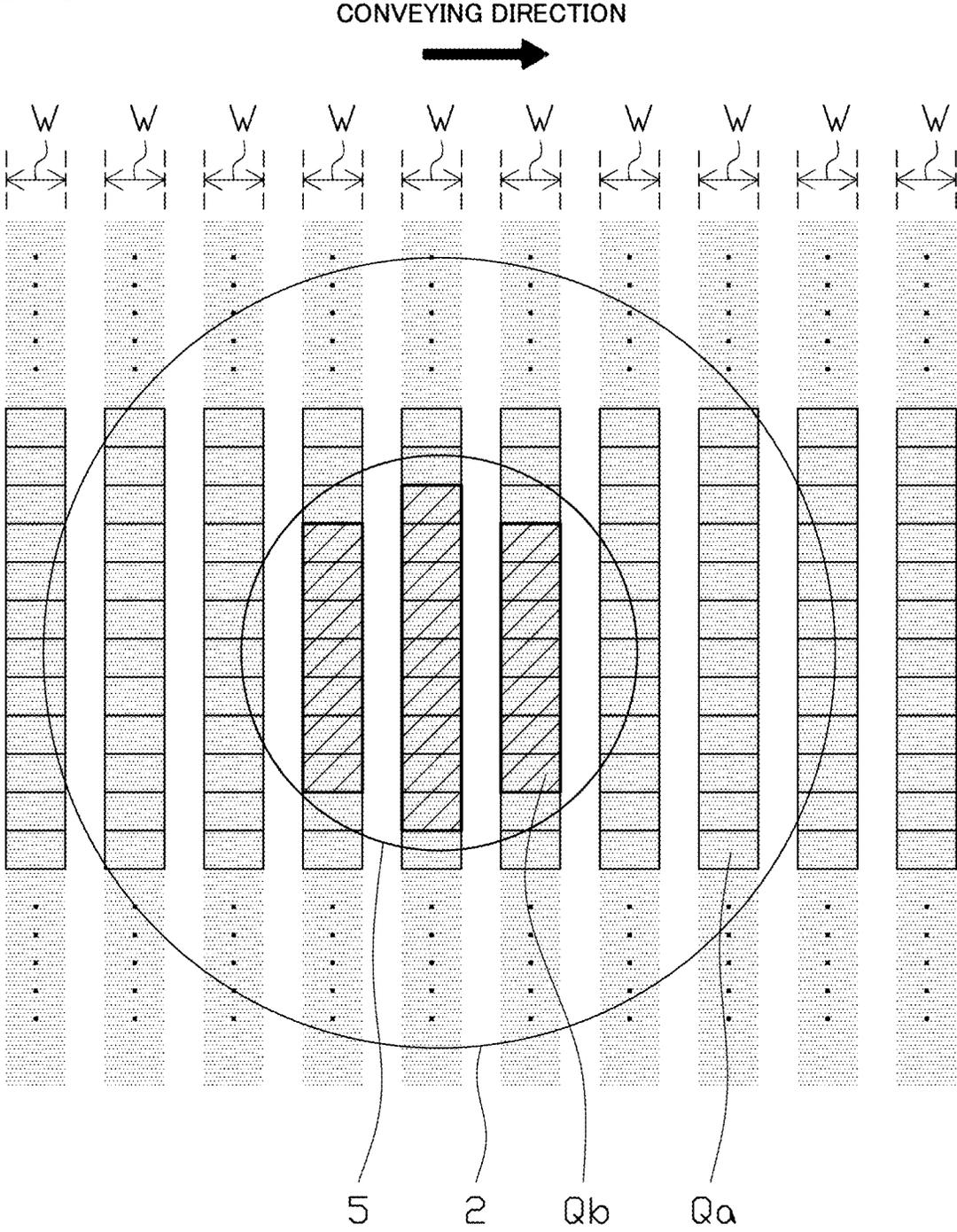


FIG. 10



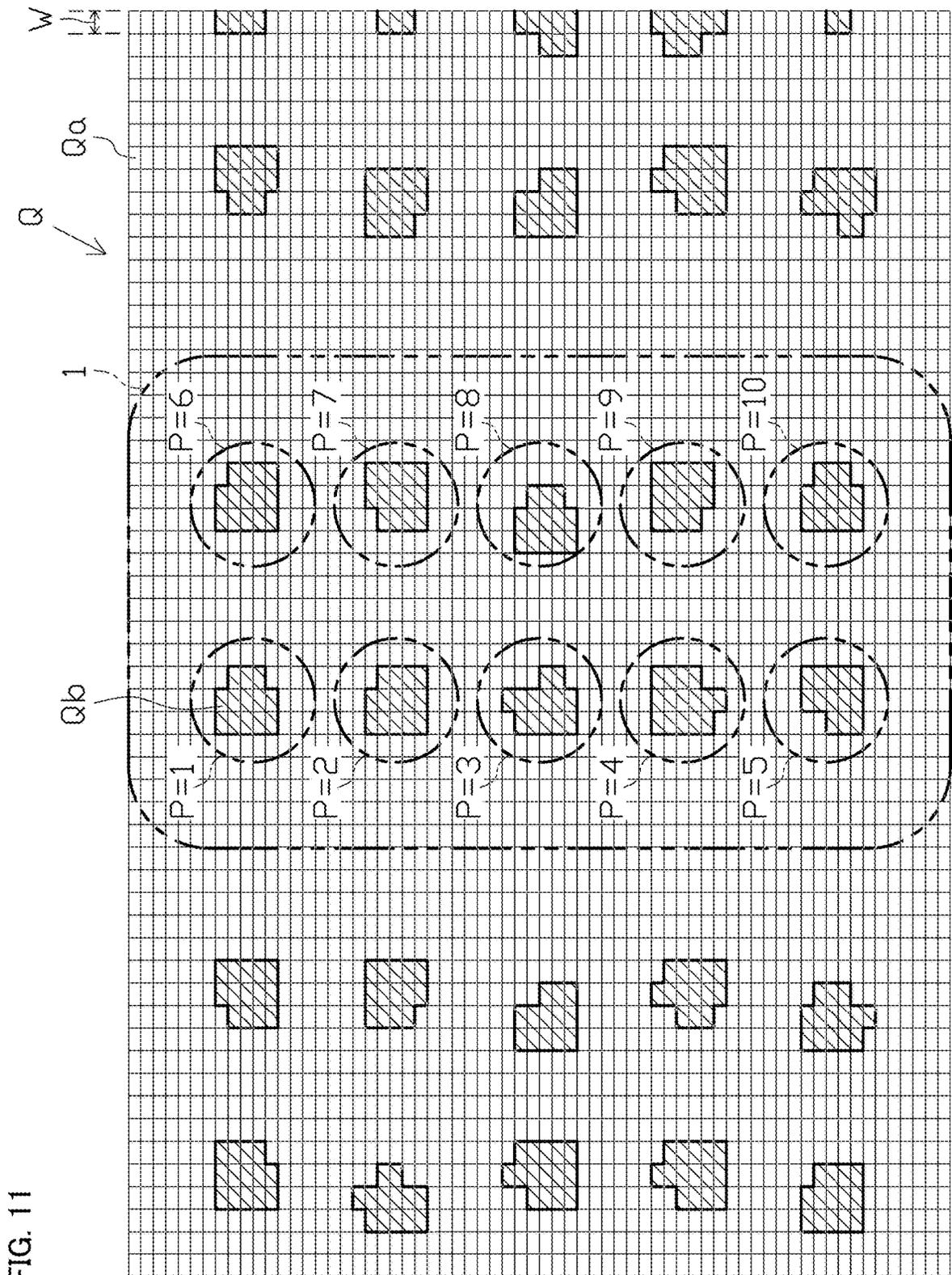


FIG. 11

FIG. 12

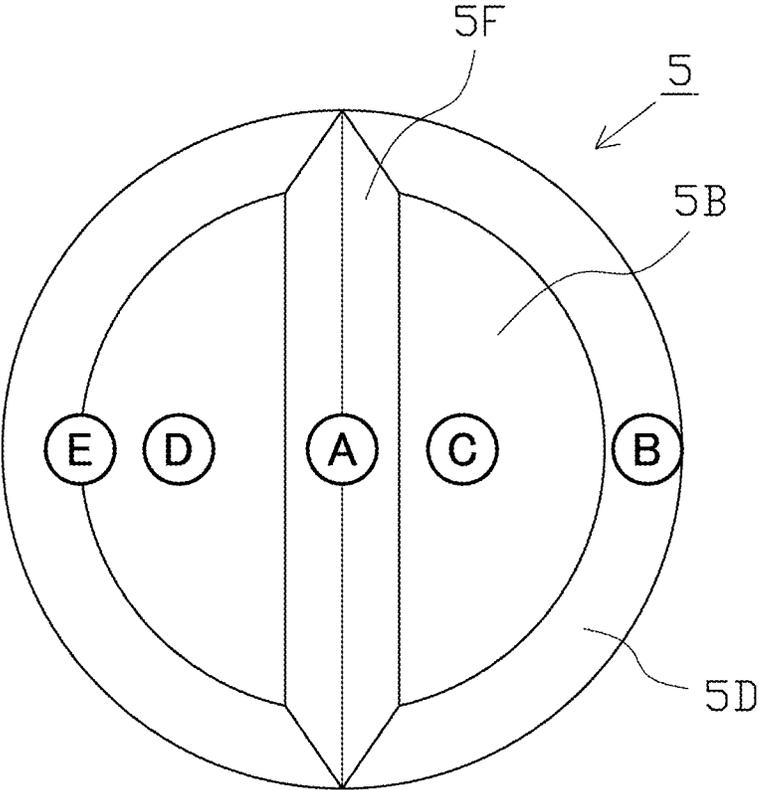
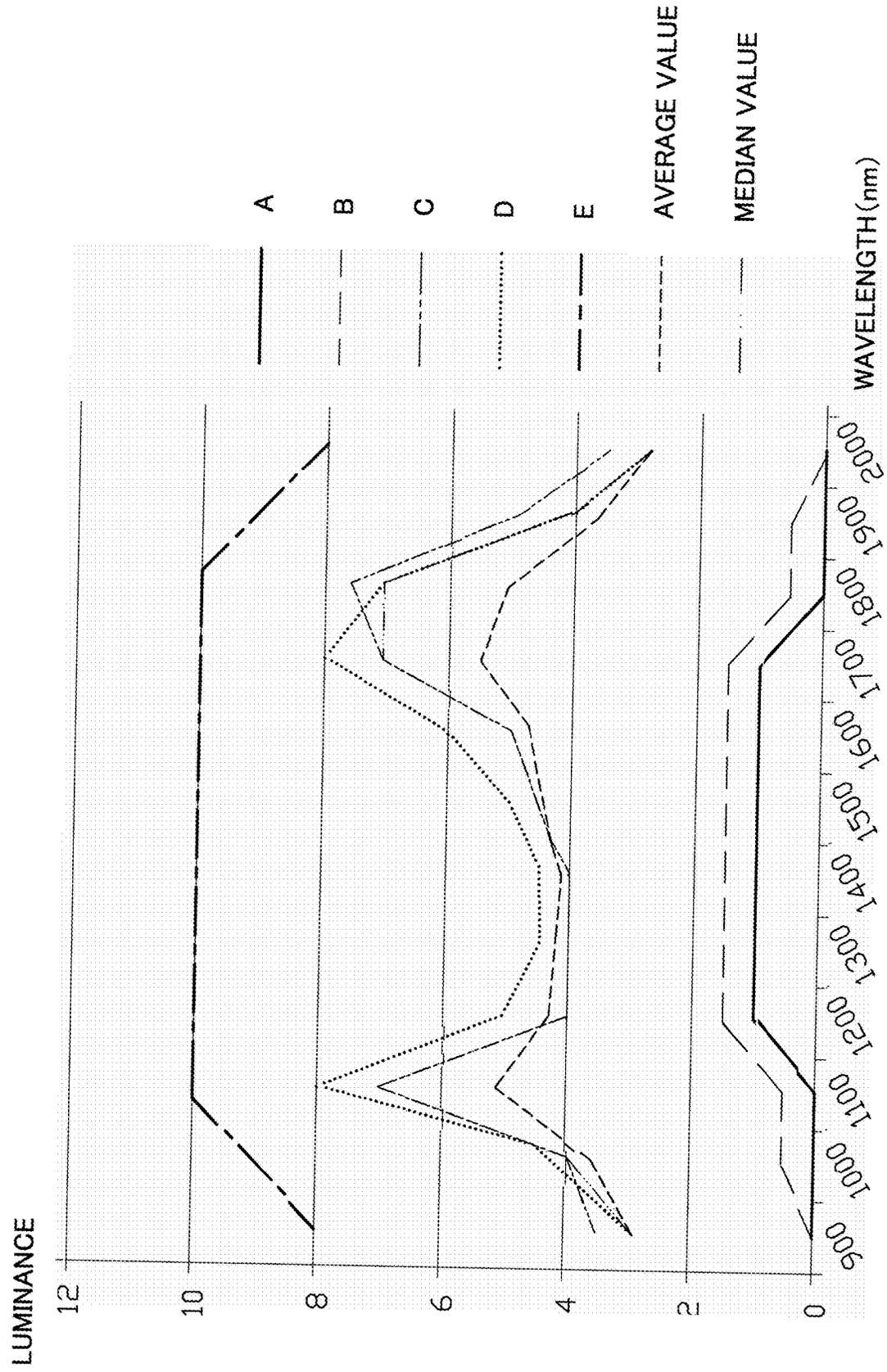


FIG. 13

WAVELENGTH	RESULTS OF MEASUREMENT					AVERAGE VALUE	MEDIAN VALUE
	A	B	C	D	E		
nm							
900	0	0	3.5	3	8	2.9	3
1000	0	0.5	4	4.5	9	3.6	4
1100	0	0.5	7	8	10	5.1	7
1200	1	1.5	4	5	10	4.3	4
1300	1	1.5	4	4.5	10	4.2	4
1400	1	1.5	4	4.5	10	4.2	4
1500	1	1.5	4.5	5	10	4.4	4.5
1600	1	1.5	5	6	10	4.7	5
1700	1	1.5	7	8	10	5.5	7
1800	0	0.5	7.5	7	10	5	7
1900	0	0.5	5	4	9	3.7	4
2000	0	0	3.5	3	8	2.9	3
SUMMATION	6	11	59	62.5	114		

FIG. 14



# INSPECTION APPARATUS, PTP PACKAGING MACHINE, AND METHOD FOR MANUFACTURING PTP SHEET

## BACKGROUND

### Technical Field

The present invention relates to an inspection device configured to perform an inspection for inclusion of any different type of object by taking advantage of spectral analysis, a Press Through Package (PTP) packaging machine, and a method of manufacturing the PTP sheet.

### Description of Related Art

A PTP sheet is generally comprised of a container film provided with pocket portions formed to be filled with objects, such as tablets, and a cover film mounted to the container film such as to seal an opening side of the pocket portions.

In manufacture of the PTP sheet, a different type inclusion inspection is performed to check for inclusion of any different type of object. A known method of such an inspection irradiates an object with near infrared light, disperses reflected light from the object by a spectroscope, and performs an analysis (for example, principal component analysis), based on spectral data obtained by taking an image of the dispersed reflected light, so as to detect inclusion of any different type of the object.

A general procedure of performing the analysis based on the spectral data averages spectral data at a plurality of points on an object to calculate average spectral data with respect to the object and identifies the type of the object, based on the average spectral data (as described in, for example, Patent Literature 1).

Another procedure detects a center position of each object, averages spectral data at a plurality of points in a neighborhood of the center position to calculate average spectral data with respect to the object, and identifies the type of the object, based on the average spectral data (as described in, for example, Patent Literature 2).

## PATENT LITERATURE

Patent Literature 1: WO 2013/002291A

Patent Literature 2: WO 2005/038443A

The procedure of simply averaging spectral data in a predetermined area on an object like the procedures of Patent Literatures 1 and 2 described above may, however, fail to give appropriate average spectral data with respect to the object.

For example, the effects of a shadow portion arising in a recess on the object (for example, a mark, a score line or the like of a tablet) or arising in an outer periphery of the object or the effects of shine caused by specularly reflected light occurring on a protrusion or the like on the object are likely to cause a significant variation in data at respective coordinate points on an identical tablet and to fail to maintain the uniformity.

## SUMMARY

By taking into account the circumstances described above, one or more embodiments of the present invention provide an inspection device configured to enhance the inspection accuracy in a different type inclusion inspection

performed by taking advantage of spectral analysis, as well as a PTP packaging machine and a manufacturing method of a PTP sheet.

The following describes one or more embodiments of the present invention. Functions and advantageous effects that are characteristic of one or more embodiments are also described as appropriate.

One or more embodiments provide an inspection device comprising an irradiation unit configured to irradiate an object with near infrared light; a spectral unit configured to disperse reflected light that is reflected from the object irradiated with the near infrared light; an imaging unit (i.e., an imaging device) configured to take a spectroscopic image of the reflected light dispersed by the spectral unit; a spectral data obtaining module (i.e., a processor) configured to obtain spectral data at a plurality of points (a plurality of coordinate positions) on the object, based on the spectroscopic image obtained by the imaging unit; a median value selecting module (i.e., the processor) configured to select a median value with regard to each wavelength (each wavelength band) in the spectral data at the plurality of points; and an analyzing module (i.e., the processor) configured to perform a predetermined analysis (for example, principal component analysis) for the object, based on median spectral data comprised of median values selected with regard to the respective wavelengths and thereby detect a different type of object.

Even when there is a variation in data at a plurality of coordinate points on one object, the configuration of one or more embodiments excludes spectral data with respect to singular points on the object by a relatively simple arithmetic operation or the like and obtains appropriate spectral data (median spectral data) suitable for spectral analysis of the object.

Even when there is, for example, a recess, a protrusion or the like on the object, this configuration enables an inspection for the object to be performed appropriately with avoiding the effects of a shadow portion arising in the recess, the effects of shine occurring in the protrusion, or the like.

As a result, this configuration significantly enhances the inspection accuracy in the different type inclusion inspection, compared with, for example, a configuration that simply averages spectral data at a plurality of points on the object.

One or more embodiments provide an inspection device comprising an irradiation unit configured to irradiate an object with near infrared light; a spectral unit configured to disperse reflected light that is reflected from the object irradiated with the near infrared light; an imaging unit configured to take a spectroscopic image of the reflected light dispersed by the spectral unit; a spectral data obtaining module configured to obtain spectral data at a plurality of points (a plurality of coordinate positions) on the object, based on the spectroscopic image obtained by the imaging unit; a typical spectrum selecting module configured to select spectral data in which a luminance value in a predetermined wavelength (wavelength band) is a median value or in which a summation of luminance values in a predetermined wavelength range (a group of a plurality of wavelength bands) is a median value, as typical spectral data representing the object among the spectral data at the plurality of points; and an analyzing module configured to perform a predetermined analysis (for example, principal component analysis) for the object, based on the typical spectral data and thereby detect a different type of object.

The configuration of one or more embodiments has similar functions and advantageous effects to those of the embodiments described above.

One or more embodiments provide a PTP packaging machine configured to manufacture a PTP sheet configured such that a predetermined object is placed in a pocket portion formed in a container film and that a cover film is mounted to the container film so as to close the pocket portion. The PTP packaging machine comprises a pocket portion forming unit (i.e., a pocket portion former) configured to form the pocket portion in the container film in a belt-like form; a filling unit (i.e., a filler) configured to fill the pocket portion with the object; a mounting unit (i.e., a mounter) configured to mount the cover film in a belt-like form to the container film with the pocket portion filled with the object, so as to close the pocket portion; a separation unit (i.e., separator) configured to separate the PTP sheet from a belt-like body (a PTP film in a belt-like form) obtained by mounting the cover film to the container film (including a punching unit configured to punch out in the unit of a sheet); and the inspection device described above.

The configuration of the PTP packaging machine provided with the inspection device described above, like the configuration of one or more embodiments, has advantages, for example, efficiently excluding a defective product containing a different type of object in the manufacturing process of the PTP sheet. Furthermore, the PTP packaging machine may be provided with a discharge unit configured to discharge a PTP sheet determined as defective by the inspection device.

In the configuration of one or more embodiments, the inspection device described above may be placed in “a previous process before the pocket portion is filled with the object by the filling unit”. This configuration allows for exclusion of a different type of object in a previous stage before the pocket portion is filled with the object and accordingly reduces the number of PTP sheets determined as defective products.

The inspection device described above may be placed in “a post process after the pocket portion is filled with the object by the filling unit and a previous process before the cover film is mounted to the container film by the mounting unit”. This configuration enables an inspection to be performed without any interference with the object and thereby further enhances the inspection accuracy.

The inspection device described above may be placed in “a post process after the cover film is mounted to the container film by the mounting unit and a previous process before the PTP sheet is separated by the separation unit”. This configuration enables an inspection to be performed in such a state that the objects are not exchanged and thereby further enhances the inspection accuracy.

The inspection device described above may be placed in “a post process after the PTP sheet is separated by the separation unit”. This configuration enables a check for inclusion of any defective product to be performed in a final stage.

One or more embodiments provide a manufacturing method of a PTP sheet to manufacture a PTP sheet configured such that a predetermined object is placed in a pocket portion formed in a container film and that a cover film is mounted to the container film so as to close the pocket portion. The manufacturing method comprises a pocket portion forming process of forming the pocket portion in the container film in a belt-like form; a filling process of filling the pocket portion with the object; a mounting process of mounting the cover film in a belt-like form to the container

film with the pocket portion filled with the object, so as to close the pocket portion; a separation process of separating the PTP sheet from a belt-like body (a PTP film in a belt-like form) obtained by mounting the cover film to the container film (including a punching process of punching out in the unit of a sheet); and an inspection process of performing an inspection for inclusion of a different type of object. The inspection process comprises an irradiation process of irradiating an object with near infrared light; a dispersion process of dispersing reflected light that is reflected from the object irradiated with the near infrared light; an imaging process (an exposure process) of taking a spectroscopic image of the dispersed reflected light; a spectral data obtaining process of obtaining spectral data at a plurality of points on the object, based on the spectroscopic image; a median value selecting process of selecting a median value with regard to each wavelength in the spectral data at the plurality of points; and an analyzing process of performing a predetermined analysis (for example, principal component analysis) for the object, based on median spectral data comprised of median values selected with regard to the respective wavelengths and thereby detecting a different type of object.

The configuration of one or more embodiments has similar functions and advantageous effects to those of the embodiments described above.

One or more embodiments provide a manufacturing method of a PTP sheet to manufacture a PTP sheet configured such that a predetermined object is placed in a pocket portion formed in a container film and that a cover film is mounted to the container film so as to close the pocket portion. The manufacturing method comprises a pocket portion forming process of forming the pocket portion in the container film in a belt-like form; a filling process of filling the pocket portion with the object; a mounting process of mounting the cover film in a belt-like form to the container film with the pocket portion filled with the object, so as to close the pocket portion; a separation process of separating the PTP sheet from a belt-like body (a PTP film in a belt-like form) obtained by mounting the cover film to the container film (including a punching process of punching out in the unit of a sheet); and an inspection process of performing an inspection for inclusion of a different type of object. The inspection process comprises an irradiation process of irradiating an object with near infrared light; a dispersion process of dispersing reflected light that is reflected from the object irradiated with the near infrared light; an imaging process (an exposure process) of taking a spectroscopic image of the dispersed reflected light; a spectral data obtaining process of obtaining spectral data at a plurality of points on the object, based on the spectroscopic image; a typical spectrum selecting process of selecting spectral data in which a luminance value in a predetermined wavelength is a median value or in which a summation of luminance values in a predetermined wavelength range is a median value, as typical spectral data representing the object among the spectral data at the plurality of points; and an analyzing process of performing a predetermined analysis (for example, principal component analysis) for the object, based on the typical spectral data and thereby detecting a different type of object.

The configuration of one or more embodiments has similar functions and advantageous effects to those of the embodiments described above.

In the configuration of one or more embodiments, the inspection process described above may be performed “before the filling process”. This configuration allows for exclusion of a different type of object in a previous stage

before the pocket portion is filled with the object and accordingly reduces the number of PTP sheets determined as defective products.

The inspection process described above may be performed "after the filling process and before the mounting process". This configuration enables an inspection to be performed without any interference with the object and thereby further enhances the inspection accuracy.

The inspection process described above may be performed "after the mounting process and before the separation process". This configuration enables an inspection to be performed in such a state that the objects are not exchanged and thereby further enhances the inspection accuracy.

The inspection process described above may be performed "after the separation process". This configuration enables a check for inclusion of any defective product to be performed in a final stage.

#### BRIEF DESCRIPTION OF DRAWINGS

FIG. 1A is a perspective view illustrating a PTP sheet, and FIG. 1B is a perspective view illustrating a PTP film;

FIG. 2 is a partly enlarged sectional view illustrating a pocket portion of the PTP sheet;

FIG. 3 is a schematic diagram illustrating the schematic configuration of a PTP packaging machine;

FIG. 4 is a block diagram illustrating the electrical configuration of an inspection device;

FIG. 5 is a perspective view schematically illustrating the arrangement configuration of the inspection device;

FIG. 6 is a schematic diagram illustrating the schematic configuration of an imaging device;

FIG. 7 is a flowchart showing a spectral data obtaining routine;

FIG. 8 is a schematic diagram illustrating an optical spectrum projected onto an imaging element;

FIG. 9 is a flowchart showing an inspection routine;

FIG. 10 is an explanatory diagram illustrating a relationship between a conveying direction imaging range and a spectral image;

FIG. 11 is a schematic diagram illustrating a spectral image;

FIG. 12 is a schematic diagram illustrating one example of a plurality of coordinate points on a tablet where spectral data are obtained;

FIG. 13 is a table showing one example of spectral data obtained at the plurality of coordinate points on the tablet; and

FIG. 14 is a graph showing plots of the respective values shown in FIG. 13.

#### DETAILED DESCRIPTION OF EMBODIMENTS

The following describes embodiments of the present invention with reference to drawings. The configuration of a PTP sheet is described first in detail.

As shown in FIGS. 1A-1B and FIG. 2, a PTP sheet 1 includes a container film 3 provided with a plurality of pocket portions 2, and a cover film 4 mounted to the container film 3 such as to close the respective pocket portions 2.

The container film 3 of one or more embodiments is made of a transparent or translucent thermoplastic resin material, such as PP (polypropylene) or PVC (polyvinyl chloride), and has translucency. The cover film 4 is, on the other hand, made of an opaque material (for example, aluminum foil)

with a sealant made of, for example, a polypropylene resin and provided on the surface thereof.

The PTP sheet 1 is formed in an approximately rectangular shape in plan view. The PTP sheet 1 is configured such that two pocket arrays are formed along a sheet short side direction and that each pocket array includes five pocket portions 2 arranged along a sheet longitudinal direction. Accordingly, the PTP sheet 1 has a total of ten pocket portions 2. One tablet 5 is placed as an object in each of the pocket portions 2.

As shown in FIG. 2, the tablet 5 of one or more embodiments is a disk-shaped plain tablet having a circular shape in plan view and is configured to have a side face 5A and a flat surface 5B and a flat rear face 5C placed across the side face 5A. According to one or more embodiments, the tablet 5 is placed in the pocket portion 2 such that the surface 5B faces a cover film 4-side and the rear face 5C faces a bottom wall-side (top wall-side) of the pocket portion 2.

The tablet 5 also has a tapered portion 5D formed by chamfering a boundary between the side face 5A and the surface 5B and a tapered portion 5E by chamfering a boundary between the side face 5A and the rear face 5C.

Furthermore, a groove-like score line 5F is marked on the surface 5B of the tablet 5 to pass through the center of the surface 5B and to be extended linearly. The score line 5F is marked only on the surface 5B and is not marked on the rear face 5C.

The PTP sheet 1 (shown in FIG. 1A) is manufactured by punching sheets from a PTP film 6 in a belt-like form (shown in FIG. 1B), which is comprised of the container film 3 in a belt-like form and the cover film 4 in a belt-like form.

The following describes the general configuration of a PTP packaging machine 10 used to manufacture the PTP sheet 1 described above, with reference to FIG. 3.

As shown in FIG. 3, a film roll of the belt-like container film 3 is wound in a roll form on a most upstream side of the PTP packaging machine 10. A pullout end of the container film 3 wound in the roll form is guided by a guide roll 13. The container film 3 is then laid on an intermittent feed roll 14 provided on a downstream side of the guide roll 13. The intermittent feed roll 14 is linked with a motor rotating in an intermittent manner, so as to convey the container film 3 intermittently.

A heating device 15 and a pocket portion forming device 16 are sequentially placed along the conveyance path of the container film 3 between the guide roll 13 and the intermittent feed roll 14. In the state that the container film 3 is heated to be relatively soft by the heating device 15, the plurality of pocket portions 2 are formed at predetermined positions of the container film 3 by the pocket portion forming device 16 (pocket portion forming process). The heating device 15 and the pocket portion forming device 16 are configured as the pocket portion forming unit according to one or more embodiments. Formation of the pocket portions 2 is performed during an interval between conveying operations of the container film 3 by the intermittent feed roll 14.

The container film 3 fed from the intermittent feed roll 14 is sequentially laid on a tension roll 18, a guide roll 19 and a film receiving roll 20 in this order. The film receiving roll 20 is linked with a motor rotating at a fixed speed, so as to continuously convey the container film 3 at a fixed speed. The tension roll 18 is configured to pull the container film 3 in a direction of applying tension by an elastic force. This configuration prevents a slack of the container film 3 due to a difference between the conveying operation by the inter-

mittent feed roll **14** and the conveying operation by the film receiving roll **20** and constantly keeps the container film **3** in the state of tension.

A tablet filling device **21** and an inspection device **22** are sequentially placed along the conveyance path of the container film **3** between the guide roll **19** and the film receiving roll **20**.

The tablet filling device **21** serves as the filling unit to automatically fill the pocket portions **2** with the tablets **5**. The tablet filling device **21** opens a shutter at every predetermined time interval to drop the tablet **5**, in synchronization with the conveying operation of the container film **3** by the film receiving roll **20**. Each of the pocket portions **2** is filled with the tablet **5** by this shutter opening operation (filling process).

The inspection device **22** is a spectroscopic analyzer configured to perform an inspection by taking advantage of spectral analysis and more specifically to check for inclusion of any different type of object. The details of the inspection device **22** will be described later.

A film roll of the belt-like cover film **4** is also wound in a roll form on a most upstream side.

A pullout end of the cover film **4** wound in the roll form is guided via a guide roll **24** to a heating roll **25**. The heating roll **25** is pressed against to be in contact with the film receiving roll **20** described above. The container film **3** and the cover film **4** are accordingly fed into between the two rolls **20** and **25**.

The container film **3** and the cover film **4** pass through between the two rolls **20** and **25** in the heated and pressed contact state, so that the cover film **4** is mounted to the container film **3** such as to close the respective pocket portions **2** (mounting process). This series of operations manufactures the PTP film **6** as a belt-like body that has the pocket portions **2** respectively filled with the tablets **5**. The heating roll **25** has minute protrusions formed on the surface of the heating roll **25** in a net-like pattern for sealing. Strongly pressing these protrusions against the films provides secure sealing. The film receiving roll **20** and the heating roll **25** are configured as the mounting unit according to one or more embodiments.

The PTP film **6** fed from the film receiving roll **20** is sequentially laid on a tension roll **27** and an intermittent feed roll **28** in this order. The intermittent feed roll **28** is linked with a motor rotating in an intermittent manner, so as to convey the PTP film **6** intermittently. The tension roll **27** is configured to pull the PTP film **6** in a direction of applying tension by an elastic force. This configuration prevents a slack of the PTP film **6** due to a difference between the conveying operation by the film receiving roll **20** and the conveying operation by the intermittent feed roll **28** and constantly keeps the PTP film **6** in the state of tension.

The PTP film **6** fed from the intermittent feed roll **28** is sequentially laid on a tension roll **31** and an intermittent feed roll **32** in this order. The intermittent feed roll **32** is linked with a motor rotating in an intermittent manner, so as to convey the PTP film **6** intermittently. The tension roll **31** is configured to pull the PTP film **6** in a direction of applying tension by an elastic force and thereby serves to prevent a slack of the PTP film **6** between these intermittent feed rolls **28** and **32**.

A slit formation device **33** and a stamping device **34** are sequentially placed along the conveyance path of the PTP film **6** between the intermittent feed roll **28** and the tension roll **31**. The slit formation device **33** serves to form a cutting slit at predetermined positions of the PTP film **6**. The

stamping device **34** serves to stamp a mark at predetermined positions of the PTP film **6** (for example, in tag portions).

The PTP film **6** fed from the intermittent feed roll **32** is sequentially laid on a tension roll **35** and a continuous feed roll **36** in this order on a downstream side of the intermittent feed roll **32**. A sheet punching device **37** is placed along the conveyance path of the PTP film **6** between the intermittent feed roll **32** and the tension roll **35**. The sheet punching device **37** serves as a sheet punching unit (separation unit) to punch out the outer periphery of each unit of PTP sheet **1** from the PTP film **6**.

The respective PTP sheets **1** punched out by the sheet punching device **37** are conveyed by a conveyor **39** and are temporarily accumulated in a finished product hopper **40** (separation process). When a PTP sheet **1** is determined as a defective product by the inspection device **22** described above, however, this PTP sheet **1** determined as defective is not conveyed to the finished product hopper **40** but is separately discharged by a non-illustrated defective sheet discharge mechanism serving as the discharge unit.

A cutting device **41** is provided on a downstream side of the continuous feed roll **36**. A non-required film portion **42** that is a residual part (scrap part) remaining in a belt-like form after punching out by the sheet punching device **37** is guided by the tension roll **35** and the continuous feed roll **36** and is subsequently led to the cutting device **41**. A driven roll is pressed against to be in contact with the continuous feed roll **36**, so that the non-required film portion **42** is placed and conveyed between the driven roll and the continuous feed roll **36**. The cutting device **41** serves to cut the non-required film portion **42** into predetermined dimensions as scraps. These scraps are accumulated in a scrap hopper **43** and are then disposed separately.

Each of the rolls such as the rolls **14**, **20**, **28**, **31** and **32** described above is arranged in a positional relationship that the roll surface is opposed to the pocket portions **2**. The surface of each roll such as the surface of the intermittent feed roll **14**, has recesses that are formed to place the pocket portions **2** therein. This configuration suppresses the pocket portions **2** from being crushed. The feeding operation with the pocket portions **2** placed in the respective recesses of each roll such as the intermittent feed roll **14** achieves the reliable intermittent feed and continuous feed.

An accumulation device, a transfer device, a packaging device and the like are sequentially placed on a downstream side of the PTP packaging machine **10**, although not being illustrated. The loose PTP sheets **1** placed in the finished product hopper **40** described above are, for example, paired to form sets of two and are then stacked in each group of multiple sets by the accumulation device. A stacked assembly of a plurality of the PTP sheets **1** is bundled with a band by the transfer device, is transferred to the packaging device, and is packaged, for example, in the form of a pillow package, by the packaging device.

The foregoing describes the outline of the PTP packaging machine **10**. The following describes the configuration of the above inspection device **22** in detail with reference to drawings. FIG. **4** is a block diagram illustrating the electrical configuration of the inspection device **22**. FIG. **5** is a perspective view schematically illustrating the arrangement configuration of the inspection device **22**.

As shown in FIG. **4** and FIG. **5**, the inspection device **22** includes an illumination device **52**, an imaging device **53**, and a control processing device **54** (i.e., a processor) configured to perform various controls, for example, drive controls of the illumination device **52** and the imaging

device 53, image processing, arithmetic operations and the like in the inspection device 22.

The illumination device 52 and the imaging device 53 are placed on an opening side of the pocket portions 2 of the container film 3. More specifically, according to one or more embodiments, an inspection for inclusion of any different type of object is performed from the opening side of the pocket portions 2 of the container film 3 in a stage prior to mounting of the cover film 4.

The illumination device 52 has a known configuration to radiate near infrared light and is configured as the irradiation unit according to one or more embodiments. The illumination device 52 is arranged to irradiate a predetermined area on the continuously fed container film 3 obliquely downward with near infrared light.

According to one or more embodiments, a halogen lamp is employed for the illumination device 52 as a light source configured to emit near infrared light having a continuous spectrum (for example, a near infrared range having a wavelength of 700 to 2500 nm). Other examples usable as the light source include a deuterium lamp, a tungsten lamp, and a xenon lamp.

As shown in FIG. 6, the imaging device 53 includes an optical lens assembly 61, a two-dimensional spectroscopic unit 62 serving as the spectral unit, and a camera 63 serving as an imaging unit (i.e., an imaging device).

The optical lens assembly 61 is comprised of a plurality of non-illustrated lenses and the like and is configured to convert incident light into parallel light. The optical lens assembly 61 has an optical axis that is set along a vertical direction (Z direction).

Furthermore, the optical lens assembly 61 is set to focus the incident light at the position of a slit 62a of the two-dimensional spectroscopic unit 62 described later. As a matter of convenience, the following describes an example of employing a double-sided telecentric lens for the optical lens assembly 61. An image-sided telecentric lens may, however, also be employable for the optical lens assembly 61.

The two-dimensional spectroscopic unit 62 is configured to include a slit 62a, an incident-side lens 62b, a spectral portion 62c and an emission-side lens 62d. The spectral portion 62c is configured to include an incident-side prism 62ca, a transmission type diffraction grating 62cb, and an emission-side prism 62cc.

Under the configuration described above, the light passing through the slit 62a is converted into parallel light by the incident-side lens 62b, is dispersed by the spectral portion 62c, and is focused by the emission-side lens 62d on an imaging element 65 of the camera 63 described later as a two-dimensional spectroscopic image (optical spectral image).

The slit 62a is formed to have a long approximately rectangular (linear) opening and is provided such that an opening width direction (short side direction) thereof is arranged along a film conveying direction of the container film 3 (X direction) and that a longitudinal direction thereof is arranged along a film width direction of the container film 3 (Y direction) orthogonal to the conveying direction. This configuration causes the two-dimensional spectroscopic unit 62 to disperse the incident light in the opening width direction of the slit 62a, i.e., in the film conveying direction (X direction).

The camera 63 includes an imaging element 65 having a light receiving surface 65a where a plurality of light-receiving elements (light receivers) 64 are two-dimensionally arranged in a matrix arrangement. According to one or more embodiments, a known CCD area sensor having

sufficient sensitivity to a wavelength range of, for example, 900 to 2000 nm, out of the near infrared range, is employed as the imaging element 65.

The imaging element is, however, not necessarily limited to this example, but another sensor having sensitivity to the near infrared range is also employable as the imaging element. For example, a CMOS sensor or an MCT (HgCdTe) sensor may be employed as the imaging element.

The imaging device 53 has a field of vision (imaging area) that is a linear region extended along the film width direction (Y direction) and that is an area including at least the entire range of the film width direction of the container film 3 (as shown by a two-dot chain line portion in FIG. 5). The field of vision of the imaging device 53 in the film conveying direction (X direction) is, on the other hand, an area corresponding to the width of the slit 62a. In other words, the field of vision is an area that causes an image of the light passing through the slit 62a (slit light) to be formed on the light receiving surface 65a of the imaging element 65.

This configuration causes each wavelength component (for example, every bandwidth of 20 nm) of the optical spectrum of the reflected light that is reflected at each position in the film width direction (Y direction) of the container film 3 to be received by each of the light-receiving elements 64 of the imaging element 65. A signal corresponding to the intensity of the light received by each of the light-receiving elements 64 is converted into a digital signal and is then output from the camera 63 to the control processing device 54. Accordingly, an image signal (spectroscopic image data) corresponding to one image plane that is imaged by the entire light receiving surface 65a of the imaging element 65 is output to the control processing device 54.

The control processing device 54 includes a CPU and input/output interfaces 71 (hereinafter referred to as "CPU and the like 71") that is configured to control the entire inspection device 22, an input device 72 that is configured as the "input unit" by, for example, a keyboard and a mouse or by a touch panel, a display device 73 that is configured as the "display unit" including a display screen such as a CRT screen or a liquid crystal screen, an image data storage device 74 that is configured to store various image data and the like, a calculation result storage device 75 that is configured to store results of various arithmetic operations and the like, and a set data storage device 76 that is configured to store various pieces of information in advance. These devices 72 to 76 are electrically connected with the CPU and the like 71.

The CPU and the like 71 is connected with the PTP packaging machine 10 such as to send and receive various signals to and from the PTP packaging machine 10. This configuration enables the CPU and the like 71 to control, for example, the defective sheet discharge mechanism of the PTP packaging machine 10.

The image data storage device 74 is configured to store, for example, spectroscopic image data taken by the imaging device 53, spectral image data obtained on the basis of the spectroscopic image data, and binarized image data after a binarization process.

The calculation result storage device 75 is configured to store, for example, inspection result data and statistical data obtained by statistically processing the inspection result data. These inspection result data and statistical data may be displayed appropriately on the display device 73.

The set data storage device 76 is configured to store, for example, loading vectors and a determination range used for

principal component analysis, and the shapes and the dimensions of the PTP sheet **1**, the pocket portion **2** and the tablet **5**.

The following describes a procedure of different type inclusion inspection (inspection process) performed by the inspection device **22**.

A spectral data obtaining routine performed to obtain spectral data is described first with reference to the flowchart of FIG. **7**. This routine is a process performed repeatedly every time a predetermined amount of the container film **3** is conveyed.

At step **S01**, the control processing device **54** first causes the imaging device **53** to perform an imaging process (exposure process), while irradiating the continuously conveyed container film **3** (the tablet **5**) with near infrared light emitted from the illumination device **52** (irradiation process).

The control processing device **54** drives and controls the imaging device **53** in response to a signal input from a non-illustrated encoder provided in the PTP packaging machine **10**, and stores spectroscopic image data taken by the imaging device **53** into the image data storage device **74**.

Accordingly, reflected light that is reflected in a conveying direction imaging range **W** (shown in FIG. **10**), out of the near infrared light emitted from the illumination device **52** toward the container film **3**, during an execution period of the imaging process of step **S01** (exposure period) enters the imaging device **53**. In other words, an image of the conveying direction imaging range **W** is taken by one imaging process.

As shown in FIG. **10**, one or more embodiments are configured such that the imaging process described above is performed every time the container film **3** is conveyed by a predetermined amount. This configuration takes an image of the optical spectrum at a plurality of positions in the conveying direction with respect to one tablet **5**.

The reflected light entering the imaging device **53** is dispersed by the two-dimensional spectroscope **62** (dispersion process) and is taken in the form of a spectroscopic image (optical spectrum) by the imaging element **65** of the camera **63** (imaging process).

FIG. **8** is a schematic diagram illustrating the state that an optical spectrum **H** of reflected light that is reflected at a predetermined position on the tablet **5** is projected onto the light receiving surface **65a** of the imaging element **65**. As a matter of convenience, FIG. **8** illustrates only the optical spectrum **H** with respect to the tablet **5**, while omitting optical spectra with respect to the other locations.

The spectroscopic image (optical spectrum) data taken by the imaging device **53** is output to the control processing device **54** during an interval period and is stored into the image data storage device **74**. The interval period herein denotes a reading period of image data. Accordingly, an imaging cycle of the imaging device **53** is expressed by a total time of the exposure period that is the execution period of the imaging process and the interval period.

After obtaining the spectroscopic image data, the control processing device **54** starts a data generation process at step **S02**.

The data generation process generates spectral data, based on the spectroscopic image data obtained at step **S01**. After generating the spectral data, the control processing device **54** stores the generated spectral data into the image data storage device **74** and then terminates this routine.

As shown in FIG. **10**, every time the container film **3** (tablet **5**) is conveyed by a predetermined amount, the conveying direction imaging range **W** is relatively moved

intermittently and the spectral data obtaining routine described above is performed repeatedly. This causes spectral data corresponding to the respective conveying direction imaging ranges **W** to be successively stored in time series along with position information in the film conveying direction (**X** direction) and in the film width direction (**Y** direction), into the image data storage device **74**. This series of operations generate a two-dimensional spectral image **Q** having spectral data with respect to each pixel (as shown in FIG. **11**).

The following describes the spectral image **Q** according to one or more embodiments. As shown in FIG. **11**, the spectral image **Q** is image data including a plurality of pixels **Qa** arrayed in a two-dimensional arrangement. The respective pixels **Qa** include spectral data (data indicating spectral intensities (luminance values) with regard to a plurality of wavelength components (wavelength bands)).

When obtaining the spectral image **Q** in a predetermined inspection range (shown by a two-dot chain line portion in FIG. **11**) corresponding to one PTP sheet **1** as an object to be inspected, the control processing device **54** performs an inspection routine.

The following describes the inspection routine with reference to the flowchart of FIG. **9**. This routine is performed repeatedly every time the spectral image **Q** in the inspection range described above is obtained.

The control processing device **54** first performs a tablet pixel extraction process at step **S11**. In this process, the control processing device **54** extracts pixels **Qb** corresponding to the tablet **5** as an object to be analyzed (hereinafter referred to as “tablet pixels” **Qb**), among the respective pixels **Qa** of the spectral image **Q**.

According to one or more embodiments, for example, the control processing device **54** determines whether the spectral intensities at a predetermined wavelength in the spectral data of the respective pixels **Qa** are equal to or greater than a predetermined reference value and processes the spectral image **Q** by a binarization process. The control processing device **54** then extracts the tablet pixels **Qb**, based on the obtained binarized image data (as shown in FIG. **10** and FIG. **11**).

According to one or more embodiments, as shown in FIG. **10**, pixels **Qa** including data of imaging only the range of the tablet **5** without being affected by a background are extracted as tablet pixels **Qb**. FIG. **10** is an explanatory diagram illustrating a relationship between the conveying direction imaging range **W** and the spectral image **Q**. Pixels extracted as the tablet pixels **Qb** are shown as hatched areas in FIGS. **10** and **11**.

The extraction procedure of the tablet pixels **Qb** is, however, not limited to this method, but another method may be employed. For example, another employable method may calculate an integrated value of spectral data (spectral intensities with regard to the respective wavelength components) with respect to each of the pixels **Qa** and determine whether the calculated integrated value is equal to or greater than a predetermined reference value, so as to extract the tablet pixels **Qb**.

The control processing device **54** subsequently performs a tablet area specification process at step **S12**. In this process, the control processing device **54** specifies areas of the ten tablets **5** placed in the respective pocket portions **2** in the inspection range.

According to one or more embodiments, for example, the control processing device **54** performs a labeling process with respect to the tablet pixels **Qb** obtained at step **S11**

described above and regards all adjacent tablet pixels Qb as a linkage component of the tablet pixels Qb belonging to one identical tablet 5.

This process specifies the range of one linkage component as a tablet area with respect to one tablet 5 placed in a predetermined pocket portion 2 (as shown in FIG. 10 and FIG. 11). In FIG. 10 and FIG. 11, a linkage component (tablet area) of a plurality of tablet pixels Qb belonging to each tablet 5 is encircled by a thick frame.

The spectral data of a plurality of tablet pixels Qb included in one linkage component (tablet area) can be treated as spectral data at a plurality of points (a plurality of coordinate positions) on one tablet 5.

Accordingly, a series of processes including the data generation process of step S02, the tablet pixel extraction process of step S11 and the tablet area specification process of step S12 configure the spectral data obtaining process according to one or more embodiments. The function of the control processing device 54 that performs these processes configures the spectral data obtaining module according to one or more embodiments.

The area specification procedure of the tablet 5 is, however, not limited to this method, but another method may be employed. For example, another employable method may determine pixels included in a predetermined range about a specific pixel at center, as pixels belonging to one identical tablet 5 with the specific pixel.

The control processing device 54 subsequently performs a median spectrum obtaining process at step S13. This process uses spectral data of a plurality of tablet pixels Qb included in the tablet area of each tablet 5 specified at step S12 as described above to obtain median spectral data with respect to the tablet 5.

More specifically, the control processing device 54 selects a median value of the spectral intensity (luminance value) with regard to each wavelength component in the spectral data of the plurality of tablet pixels Qb belonging to the tablet area of one tablet 5. The control processing device 54 then stores a set of these median values with regard to the respective wavelength components as median spectral data with respect to the tablet 5 into the calculation result storage device 75.

Accordingly, the process of selecting the median value with regard to each wavelength component configures the median value selecting process according to one or more embodiments. The function of the control processing device 54 that performs this process configures the median value selecting module according to one or more embodiments.

The following describes the process of selecting the median value of the spectral intensity with regard to each wavelength component and obtaining the median spectral data, with reference to a concrete example shown in FIGS. 12 to 14.

FIG. 12 is a schematic diagram illustrating one example of a plurality of coordinate points A to E on one tablet 5 where spectral data are obtained. FIG. 13 is a table showing one example of spectral data (spectral intensities with regard to the respective wavelength components) and the like obtained at these coordinate points A to E. FIG. 14 is a graph showing plots of the data of FIG. 13.

As shown in FIG. 12, the coordinate point A is located in the score line 5F and includes a shadow portion having low luminance of reflected light. Accordingly, as shown in FIG. 13 and FIG. 14, the spectral data with respect to the coordinate point A is data having low luminance on the whole.

The coordinate point B is located in the tapered portion 5D on the side away from the illumination device 52 (as shown in FIG. 12) and includes a shadow portion having low luminance of reflected light, like the coordinate point A. Accordingly, the spectral data with respect to the coordinate point B is also data having low luminance on the whole (as shown in FIG. 13 and FIG. 14).

The coordinate point E is, on the contrary, located at a boundary between the tapered portion 5D on the side near to the illumination device 52 and a flat plane of the surface 5B (as shown in FIG. 12) and includes a specular reflection portion (shine portion) such as a corner portion having high luminance of reflected light. Accordingly, the spectral data with respect to the coordinate point E is data having high luminance on the whole (as shown in FIG. 13 and FIG. 14).

The coordinate points C and D are, on the other hand, located on the flat plane of the surface 5B (as shown in FIG. 12) and include neither a shadow portion nor a specular reflection portion. Accordingly, the spectral data with respect to the coordinate points C and D are data reflecting the component of the tablet 5 relatively appropriately (as shown in FIG. 13 and FIG. 14).

In the example illustrated in FIG. 13 and FIG. 14, a spectral intensity "3" in a wavelength band of 900 nm with respect to the coordinate point D is selected as a median value in the wavelength band of 900 nm, based on the spectral data at the plurality of coordinate points A to E. In FIG. 13, cells corresponding to median values are filled with a dotted pattern for the purpose of easier recognition of the median values.

A spectral intensity "4" in a wavelength band of 1000 nm with respect to the coordinate point C is subsequently selected as a median value in the wavelength band of 1000 nm.

Similarly, spectral intensities "7", "4", "4", "4", "4.5", "5" and "7" with regard to the respective wavelength components in a wavelength band of 1100 nm to a wavelength band of 1700 nm with respect to the coordinate point C are selected as median values with regard to the respective wavelength components in the wavelength band of 1100 nm to the wavelength band of 1700 nm.

Spectral intensities "7", "4" and "3" with regard to the respective wavelength components in a wavelength band of 1800 nm to a wavelength band of 2000 nm with respect to the coordinate point D are also selected as median values with regard to the respective wavelength components in the wavelength band of 1800 nm to the wavelength band of 2000 nm.

A set of the median values with regard to the respective wavelength components selected as described above (as shown in a rightmost column in the table of FIG. 13) are obtained as median spectral data with respect to the tablet 5.

As clearly understood from average values of the spectral intensities (luminance values) with regard to the respective wavelength components in the spectral data at the plurality of coordinate points A to E shown in FIG. 13 and FIG. 14, these average values are affected by the spectral data with respect to the coordinate points A, B and E that substantially make a noise component (by the shadow portions arising in the score line 5F and in the tapered portion 5D and by the shine due to specular reflection) and not data approximating the relatively appropriate spectral data with respect to the coordinate points C and D.

As clearly shown by the comparison with the above average values, on the other hand, the median spectral data

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described above are data approximating the relatively appropriate spectral data with respect to the coordinate points C and D.

After obtaining the median spectral data with respect to each of the ten tablets **5** placed in the respective pocket portions **2** included in the inspection range as described above, the control processing device **54** collectively stores these obtained median spectral data as a median spectral data group with respect to one inspection range into the calculation result storage device **75**.

At subsequent step **S14**, the control processing device **54** sets a counter value **P** of a pocket number counter provided in the calculation result storage device **75** to an initial value "1".

The "pocket number" denotes a serial number set corresponding to each of the ten pocket portions **2** included in one inspection range. The position of each pocket portion **2** can be specified by the counter value **P** of the pocket number counter (hereinafter simply referred to as "pocket number counter value **P**") (as shown in FIG. **11**).

In the illustrated example of FIG. **11**, for example, an uppermost pocket portion **2** in a left column is set as the pocket portion **2** corresponding to a pocket number counter value [1]. A lowermost pocket portion **2** in a right column is set as the pocket portion **2** corresponding to a pocket number counter value [10].

The control processing device **54** subsequently performs an analysis object data extraction process at step **S15**. In this process, the control processing device **54** extracts median spectral data of the tablet **5** placed in a pocket portion **2** corresponding to a current pocket number counter value **P** (for example,  $P=1$ ), from the median spectral data group with respect to one inspection range (median spectral data of the ten tablets **5**) obtained at step **S13** described above.

The control processing device **54** subsequently performs an analysis process for the median spectral data of the tablet **5** extracted at step **S15** (step **S16**). This process corresponds to the analyzing process according to one or more embodiments. The function of the control processing device **54** that performs this process configures the analyzing module according to one or more embodiments.

According to one or more embodiments, for example, the control processing device **54** uses a loading vector obtained in advance and performs principal component analysis (PCA) for the median spectral data of the tablet **5** obtained at step **S13** described above. More specifically, the control processing device **54** calculates a principal component point by arithmetic operation of the above loading vector and the median spectral data of the tablet **5**.

The control processing device **54** subsequently performs a tablet good/poor quality judgment process at step **S17**. In this process, the control processing device **54** determines whether the tablet **5** placed in the pocket portion **2** corresponding to the current pocket number counter value **P** (for example,  $P=1$ ) is a non-defective product (identical type of object) or a defective product (different type of object), based on the result of analysis obtained by the analysis process performed at step **S16** as described above.

More specifically, the control processing device **54** plots the principal component point calculated at step **S16** described above in a PCA chart and determines the tablet **5** as a non-defective product (identical type of object) when the plotted data is within a non-defective range set in advance, while determining the tablet **5** as a defective product (different type of object) when the plotted data is out of the non-defective range.

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The control processing device **54** then stores the result of determination with respect to the tablet **5** ("non-defective" or "defective") into the calculation result storage device **75**.

The control processing device **54** subsequently adds "1" to the current pocket number counter value **P** at step **S18** and proceeds to step **S19** to determine whether the newly set pocket number counter value **P** exceeds a maximum value **Pmax**. The maximum value **Pmax** denotes a maximum value of the number of pocket portions **2** included in one inspection range ("10" according to one or more embodiments).

In the case of negative determination, the control processing device **54** goes back to step **S15** to perform the series of processing described above again. In the case of affirmative determination, on the other hand, the control processing device **54** determines that the good/poor quality judgment of the tablets **5** has been completed with respect to all the pocket portions **2** and proceeds to step **S20**.

At subsequent step **S20**, the control processing device **54** performs a sheet good/poor quality judgment process. In this process, the control processing device **54** determines whether the PTP sheet **1** corresponding to the inspection range is a non-defective product or a defective product, based on the results of determination in the tablet good/poor quality judgment process performed at step **S17** described above.

More specifically, when there is any tablet **5** determined as "defective" in the inspection range, the control processing device **54** determines the PTP sheet **1** corresponding to the inspection range as a "defective product" and proceeds to step **S21**.

When there is no tablet **5** determined as "defective" in the inspection range, on the other hand, the control processing device **54** determines the PTP sheet **1** corresponding to the inspection range as a "non-defective product" and proceeds to step **S22**.

The control processing device **54** performs a defective product process at step **S21** to store the result of determination as the "defective product" with respect to the PTP sheet **1** into the calculation result storage device **75**, outputs this determination result to the defective sheet discharge mechanism or the like of the PTP packaging machine **10**, and then terminates the inspection routine.

The control processing device **54**, on the other hand, performs a non-defective product process at step **S22** to store the result of determination as the "non-defective product" with regard to the PTP sheet **1** (inspection range) into the calculation result storage device **75**, and then terminates the inspection routine.

As described above in detail, even when there is a variation in data at a plurality of coordinate points on one tablet **5**, the configuration of one or more embodiments excludes the spectral data with respect to singular points on the tablet **5** (for example, the coordinate points A, B and E shown in FIG. **12**) by a relatively simple arithmetic operation or the like and obtains appropriate spectral data (median spectral data) suitable for spectral analysis of the tablet **5**.

Even when there are, for example, the score line **5F**, the tapered portion **5D** and the like on the tablet **5**, this configuration enables an inspection for the tablet **5** to be performed appropriately with avoiding the effects of, for example, the shadow portions arising in the score line **5F** and the like and the shine occurring in the corner portion or the like.

As a result, this configuration significantly enhances the inspection accuracy in the different type inclusion inspection.

tion, compared with, for example, a configuration that simply averages spectral data at a plurality of points on the tablet 5.

The present invention is not limited to the description of the above embodiments but may be implemented, for example, by configurations described below. The present invention may also be naturally implemented by applications and modifications other than those illustrated below.

(a) The embodiments described above illustrates the case where the object is the tablet 5. The type or the like of the object is, however, not specifically limited. The object may be, for example, a capsule, a supplement, or a food item. The tablet includes a solid preparation such as an uncoated plain tablet and a sugar-coated tablet.

In the case where the object of inspection is a capsule, specularly reflected light that is reflected from a capsule body makes shine and affects an inspection for a medicinal substance placed inside of the capsule body. The configuration of one or more embodiments, however, reduces the possibility of such an issue.

Moreover, the shape and the like of the object are not limited to the description of the above embodiments. The above embodiments illustrate the tablet 5 that is the disk-shaped plain tablet having the circular shape in plan view and that has the tapered portions 5D and 5E formed in the outer peripheries of both the surface 5B and the rear face 5C and the score line 5F marked in the surface 5B.

The object is, however, not limited to the above but may be a tablet with omission of the tapered portions 5D and 5E and/or the score line 5F. The object may also be a tablet with a recess marked.

Furthermore, the object may be, for example, a lens-shaped tablet that is formed in a circular shape in plan view and that has different thicknesses in a central part and in a peripheral part or may be a tablet having a substantially elliptical shape, a substantially oval shape, a substantially polygonal shape or the like in plan view.

(b) The materials of the container film 3 and the cover film 4 are not limited to those of the embodiments described above, but other materials may be employed. For example, the container film 3 may be made of a metal material that contains aluminum as a main material, such as an aluminum laminated film.

(c) The arrangement and the number of the pocket portions 2 in the PTP sheet 1 are not limited at all to those described in the above embodiments. A PTP sheet may be configured to have any of various other arrangements of and any number of pocket portions, for example, a total of twelve pocket portions arrayed in three lines.

(d) The above embodiments are configured to irradiate the tablets 5 and take the images of the tablets 5 from the opening side of the pocket portions 2 and perform the different type inclusion inspection by the inspection device 22 in a post process after the pocket portions 2 are filled with the tablets 5 and a previous process before the cover film 4 is mounted to the container film 3.

This configuration is, however, not essential. When the container film 3 is made of a transparent material, a modification may be configured to irradiate the tablets 5 and take the images of the tablets 5 across the pocket portions 2 (across the container film 3) and perform the different type inclusion inspection by the inspection device 22 in the post process after the pocket portions 2 are filled with the tablets 5 and the previous process before the cover film 4 is mounted to the container film 3.

In the configuration of irradiating and imaging the tablets 5 across the pocket portions 2 and performing the inspection,

specularly reflected light that is reflected from the pocket portions 2 is likely to make shine and affect the inspection. The configuration of one or more embodiments, however, reduces the possibility of such an issue.

Another modification may be configured to irradiate the tablets 5 and take the images of the tablets 5 across the pocket portions 2 from the container film 3-side of the PTP film 6 and perform the different type inclusion inspection by the inspection device 22 in a post process after the cover film 4 is mounted to the container film 3 and in a previous process before the PTP sheet 1 is punched out from the PTP film 6.

Another modification may be configured to irradiate the tablets 5 and take the images of the tablets 5 across the pocket portions 2 from the container film 3-side of the PTP sheet 1 conveyed by the conveyor 39 and perform the different type inclusion inspection by the inspection device 22 in a post process after the PTP sheet 1 is punched out from the PTP film 6.

In this case, in place of the configuration that the inspection device 22 is provided inside of the PTP packaging machine 10 (inline configuration), the inspection device 22 may be provided as a device separate from the PTP packaging machine 10 to perform offline inspection of the PTP sheet 1. In this modification, the inspection device 22 may be equipped with a conveyance unit configured to convey the PTP sheet 1.

Another modification may be configured to perform the different type inclusion inspection by the inspection device 22 in a previous process before the pocket portions 2 are filled with the tablets 5. For example, the modification may be configured to perform the inspection in a previous stage before the tablets 5 are supplied to the tablet filling device 21. In this case, the inspection device 22 may be provided as a device separate from the PTP packaging machine 10 to perform offline inspection of the tablets 5.

In the case of performing the offline inspection, a modification may be configured to perform the inspection in such a state that the PTP sheet 1 and the tablets 5 are not continuously conveyed but are at stop. From the viewpoint of enhancing the productivity, however, the inline inspection should be performed while the PTP film 6 or the container film 3 is conveyed continuously.

In the manufacturing field of the PTP sheet 1 or the like, there is a recent demand for increasing the speed of various inspections such as different type inclusion inspection, accompanied with an increase in the production rate. For example, an inspection performed on the PTP packaging machine 10 may be required to inspect 100 or more tablets 5 per second.

(e) The configurations of the illumination device 52 and the imaging device 53 are not limited to those described in the above embodiments. For example, a reflection type diffraction grating, a prism or the like may be employed as the spectral unit, in place of the two-dimensional spectroscopy 62.

(f) The embodiments described above are configured to analyze the spectral data by principal component analysis (PCA). This technique is, however, not essential. Another known technique, such as PLS regression analysis may be employed to analyze the spectral data.

(g) According to the embodiments described above, the different type inclusion inspection with respect to the tablet 5 is performed by the configuration of selecting a median value of the spectral intensity with regard to each wavelength component in the spectral data at a plurality of coordinate points on one tablet 5 and obtaining a set of median values selected with regard to the respective wave-

length components as median spectral data with respect to the tablet **5** by the median spectrum obtaining process at step **S13** and of analyzing the median spectral data by the analysis process at step **S16**.

This configuration is, however, not essential. A modification may perform the different type inclusion inspection with respect to the tablet **5** by a configuration of performing a typical spectrum obtaining process, in place of the median spectrum obtaining process of step **S13**, to select typical spectral data representing the tablet **5** among the spectral data at a plurality of coordinate points on one tablet **5** and of analyzing the typical spectral data by the analysis process at step **S16**.

The process of performing the typical spectrum obtaining process configures the typical spectrum selecting process according to the embodiments. The function of the control processing device **54** that performs this process configures the typical spectrum selecting module according to the embodiments.

For example, an employable procedure of the typical spectrum obtaining process may be configured to select spectral data in which a summation of the spectral intensities (luminance values) in a predetermined wavelength range (in a group of a plurality of wavelength bands) is a median value, as typical spectral data representing the tablet **5** among the spectral data at a plurality of coordinate points on one tablet **5**.

In the case where the above typical spectrum obtaining process is performed in the concrete example shown in FIG. **13**, the procedure calculates a summation of the spectral intensities with regard to the respective wavelength components (wavelength bands) in the entire wavelength range (in the wavelength band of 900 nm to the wavelength band of 2000 nm) by using the spectral data obtained at each of the plurality of coordinate points A to E on one tablet **5**. The summations of the spectral intensities with respect to the plurality of coordinate points A to E are respectively "6", "11", "59", "62.5" and "114". The summation "59" is a median value of these summations. Accordingly, the procedure selects spectral data with respect to the coordinate point C corresponding to this summation, as the typical spectral data representing the tablet **5**.

In place of the above procedure, a modified procedure may be configured to select spectral data in which a summation of the spectral intensities with regard to the respective wavelength components in a partial wavelength range (for example, in the wavelength band of 1800 nm to the wavelength band of 2000 nm) is a median value, as the typical spectral data representing the tablet **5** among the spectral data obtained at the plurality of coordinate points A to E.

In the illustrated example of FIG. **13**, the spectral data in which the summation of the spectral intensities with regard to the respective wavelength components in the wavelength band of 1800 nm to the wavelength band of 200 nm is the median value is spectral data with respect to the coordinate point D. In this case, the spectral data with respect to the coordinate point D is selected as the typical spectral data representing the tablet **5**.

Another modified procedure of the typical spectrum obtaining process may be configured to select spectral data in which a spectral intensity (luminance value) in a predetermined wavelength (in one wavelength band) is a median value, as the typical spectral data representing the tablet **5** among spectral data at a plurality of coordinate points on one tablet **5**.

In the illustrated example of FIG. **13**, in the case of selecting spectral data in which the spectral intensity in a wavelength band of 1500 nm is a median value, as the typical spectral data representing the tablet **5** among the spectral data respectively obtained at the plurality of coordinate points A to E on one tablet **5**, spectral data with respect to the coordinate point C is selected as the typical spectral data representing the tablet **5**.

In the case of selecting spectral data in which the spectral intensity in a wavelength band of 900 nm is a median value, as the typical spectral data representing the tablet **5**, on the other hand, spectral data with respect to the coordinate point D is selected as the typical spectral data representing the tablet **5**.

The spectral intensities in the respective wavelength bands included in the near infrared light emitted from the light source are not uniform. Thus, spectral data in which the summation of the spectral intensities in a group of a plurality of wavelength bands is a median value may be selected as the typical spectral data representing the tablet **5**.

From this point of view, the configuration of the above embodiments that performs the different type inclusion inspection of the tablet **5** based on the median spectral data comprised of the median values selected with regard to the respective wavelength components may be adopted rather than the configuration of performing the different type inclusion section of the tablet **5** based on the typical spectral data.

(h) The above embodiments are configured to perform the imaging process every time a predetermined amount of the container film **3** is conveyed and thereby to obtain spectral data at a plurality of positions in the film conveying direction (X direction) with regard to one tablet **5**. This configuration is, however, not essential. A modification may be configured to obtain spectral data at only one position in the film conveying direction (X direction) with regard to one tablet **5**. In this modified configuration, spectral data are obtained at a plurality of positions in the film width direction (Y direction) of the container film **3** with regard to one tablet **5**.

Although the disclosure has been described with respect to only a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that various other embodiments may be devised without departing from the scope of the present invention. Accordingly, the scope of the invention should be limited only by the attached claims.

#### REFERENCE SIGNS LIST

1 . . . PTP sheet, 2 . . . pocket portion, 3 . . . container film, 4 . . . cover film, 5 . . . tablet, 5D, 5E . . . tapered portions, 5F . . . score line, 10 . . . PTP packaging machine, 22 . . . inspection device, 52 . . . illumination device, 53 . . . imaging device, 54 . . . control processing device, 62 . . . two-dimensional spectroscopy, 63 . . . camera, Q . . . spectral image, Qa . . . pixel, Qb . . . tablet pixel

What is claimed is:

1. An inspection device comprising:
  - an illumination device that irradiates an object with near infrared light;
  - a spectroscopy that disperses reflected light from the object irradiated with the near infrared light;
  - an imaging device that takes a spectroscopic image of the reflected light dispersed by the spectroscopy; and
  - a processor that:

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obtains spectral data at a plurality of points on the object based on the spectroscopic image obtained by the imaging device;  
 selects, as typical spectral data representing the object from among the spectral data at the plurality of points, one of:  
 spectral data in which a luminance value in a predetermined wavelength is a median value; and  
 spectral data in which a summation of luminance values in a predetermined wavelength range is a median value; and  
 performs a predetermined analysis for the object based on the typical spectral data and detects a different type of object.

2. A Press Through Package (PTP) packaging machine that manufactures a PTP sheet, the PTP packaging machine comprising:  
 the inspection device according to claim 1;  
 a pocket portion former that forms a pocket portion in a container film of a belt-like shape;  
 a filler that fills an object into the pocket portion;  
 a mounter that mounts a cover film onto the container film to close the pocket portion; and  
 a separator that separates the PTP sheet from a belt-like body obtained by mounting the cover film to the container film.

3. A manufacturing method for manufacturing a Press Through Package (PTP) sheet, the manufacturing method comprising:

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forming a pocket portion in a container film of a belt-like shape;  
 filling an object into the pocket portion;  
 mounting a cover film onto the container film to close the pocket portion; and  
 inspecting the PTP sheet for inclusion of a different type of object, wherein  
 the inspecting comprises:  
 irradiating an object with near infrared light;  
 dispersing reflected light from the object irradiated with the near infrared light;  
 taking a spectroscopic image of the dispersed reflected light;  
 obtaining spectral data at a plurality of points on the object based on the spectroscopic image;  
 selecting, as typical spectral data representing the object from among the spectral data at the plurality of points, one of:  
 spectral data in which a luminance value in a predetermined wavelength is a median value; and  
 spectral data in which a summation of luminance values in a predetermined wavelength range is a median value; and  
 performing a predetermined analysis for the object based on the typical spectral data and detecting a different type of object.

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